Posudek práce

předložené na Matematicko-fyzikální fakultě
Univerzity Karlovy

❑ posudek oponenta
❑ diplomové práce

Autor: Bc. Matěj Makeš
Název práce: Mapping of Changes in Optical and Magneto-Optical Responses of Ni-Mn-Ga Thin Films
Studijní program a obor: Optics and optoelectronics
Rok odevzdání: 2024

Jméno a tituly vedoucího/oponenta: Mgr. Jan Zemen, Ph.D.
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Odborná úroveň práce:
❑ vynikající

Věcné chyby:
❑ téměř žádné

Výsledky:
❑ originální

Rozsah práce:
❑ standardní

Grafická, jazyková a formální úroveň:
❑ vynikající

Tiskové chyby:
❑ téměř žádné

Celková úroveň práce:
❑ vynikající

Slovní vyjádření, komentáře a připomínky vedoucího/oponenta:

The candidate carried out a systematic study of optical and magneto-optical properties of thin Ni-Mn-Ga films epitaxially grown on stress-mediating Cr layer and MgO substrate by magnetron sputtering. The combination of ellipsometry and polar-MOKE spectroscopy allowed for evaluation of diagonal and off-diagonal elements of the complex permittivity tensor via regression analyses. The spectral features of these elements are highly sensitive to changes in the magnetic and lattice structure of the material so they are well suited for tracking strain relaxation and the presence of martensitic transformation in the studied Heuser alloy.

The thesis carefully presents the fundamental physics used in this project including light-matter interaction, ellipsometry, and Višňovský-Yeh's matrix formalism. The student has contributed to the implementation of the complex model of propagation of light in stratified media in Matlab and used it to derive the off-diagonal elements of the relative permittivity tensor.

The experimental part of the thesis represents the core of the original work of the candidate:
(a) measurement of the temperature dependence of the optical and magneto-optical responses of a 400 nm thick Ni-Mn-Ga film by heating and cooling across the martensitic transformation;
(b) measurements of thickness dependence (from 10nm to 700nm) of the same properties in Ni-Mn-Ga films with different stoichiometric compositions (Ni47Mn32Ga21 and Ni48Mn30Ga22) which is an extension of the bachelor thesis of the candidate.

Případné otázky při obhajobě a náměty do diskuze:

1) The thesis states that the magnetometry measurement was provided by Verbeno (2021) and that it indicates at least a partial phase transition at 42 °C to 50 °C during heating from and at 44 °C to 36 °C during cooling. What is meant by partial? Is it possible that only a part of the film transforms and the rest is clamped by the substrate? Please comment.

2) In case of the optical measurement at zero field (sec. 7.1.1), the thin film spectra behave in the opposite way with changing temperature compared to bulk Ni-Mn-Ga. I could not find an attempt to interpret this surprising observation. Please provide some hypothesis if possible.

3) In case of the Kerr spectra (sec. 7.1.2), the variation with temperature seems to be significantly smaller even across the martensitic transformation than the variation with film thickness (sec. 7.2.2). It is suggested that this is due to the strain relaxation dependent on film thickness. It is unfortunate that this strain effect seems stronger than the change in spectrum induced by the martensitic transformation. Please comment on the effect of the penetration depth – in case of films thinner than 50 nm, could the Cr layer also affect the resulting spectrum?

4) In case of the two peaks in Kerr azimuth, the comparison to bulk spectra (Beran et al., 2015) suggests that the thinner films have austenite structure and thicker films have martensitic structure (the second peak is higher in films 10 to 50 nm thick). Could this analysis be applied to the 400 nm thick film studied at a range of temperatures? The first peak there is always higher (sec. 7.1.2) despite the temperature being above and below the martensitic transformation as confirmed by the magnetometry data.

Práci
❑ doporučuji
uznat jako diplomovou/bakalářskou.

Navrhuji hodnocení stupněm:
❑ výborně

Místo, datum a podpis vedoucího/oponenta:
V Praze 2.2.2024